

## CLAIMS

We claim:

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1. An electrode structure adapted for use with a fuel cell system, characterized in that the electrode structure comprises a silicon substrate having one or more selectively doped regions thereon, wherein each of the one or more selectively doped regions is adapted to function as a current collector for the transmission of an electrical current.

2. The electrode structure of claim 1 wherein the fuel cell system is a direct methanol fuel cell system.

3. The electrode structure of claim 1 wherein the silicon substrate is derived from a silicon wafer.

4. The electrode structure of claim 1 wherein the silicon substrate comprises one or more discrete porous regions.

5. The electrode structure of claim 4 wherein the one or more discrete porous regions define inner pore surfaces, wherein the inner pore surfaces have catalyst particles uniformly dispersed thereon.

6. The electrode structure of claim 4 wherein the one or more discrete porous regions are defined by an array of acicular pores disposed across a top surface area of the electrode structure.

7. The electrode structure of claim 6 wherein the array of acicular pores defines inner pore surfaces, wherein the inner pore surfaces have catalyst particles uniformly dispersed thereon.

8. The electrode structure of claim 7 wherein the catalyst particles comprise a plurality of chemisorbed metallic particles.

9. The electrode structure of claim 8 wherein the plurality of chemisorbed metallic particles are platinum, ruthenium, or a combination thereof.

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10. An electrode structure adapted for use with a fuel cell system, the electrode structure comprising a silicon substrate having one or more discrete porous bulk matrix regions disposed across a top surface, wherein each of the one or more discrete bulk matrix porous regions is defined by a plurality pores that extend into the silicon substrate, wherein the plurality of pores defines inner pore surfaces, and wherein the inner pores surfaces have catalyst particles uniformly dispersed thereon.

11. The electrode structure of claim 10 wherein the fuel cell system is a direct methanol fuel cell system.

12. The electrode structure of claim 10 wherein the silicon substrate is derived from a silicon wafer.

13. The electrode structure of claim 10 wherein the catalyst particles comprise a plurality of chemisorbed metallic particles.

14. The electrode structure of claim 13 wherein the plurality of chemisorbed metallic particles are platinum, ruthenium, or a combination thereof.

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15. An electrode structure adapted for use with a fuel cell system, characterized in that the electrode structure comprises a silicon substrate having one or more selectively doped regions thereon, wherein each of the one or more selectively doped regions is adapted to function as a current collector for the transmission of an electrical current, and wherein the silicon substrate further comprises one or more discrete porous bulk matrix regions disposed across a top surface, wherein each of the one or more discrete bulk matrix

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porous regions is defined by a plurality of pores that extend into the silicon substrate, wherein the plurality of pores defines inner pore surfaces, wherein the inner pore surfaces have catalyst particles uniformly dispersed thereon, and wherein the one or more selectively doped regions corresponds to the one or more discrete porous bulk matrix regions.

16. The electrode structure of claim 15 wherein the fuel cell system is a direct liquid feed fuel cell system.

17. The electrode structure of claim 15 wherein the plurality of pores are interconnecting mesoporous acicular pores, interconnecting macroporous acicular pores, or a combination thereof.

18. The electrode structure of claim 15 wherein the catalyst particles are chemisorbed metallic nanoparticles.

19. The electrode structure of claim 18 wherein the chemisorbed metallic nanoparticles are platinum, ruthenium, or a combination thereof.